REAL TIME VISUALIZATION

OF GALILEO SCIENCE INSTRUMENT DATA

DURING THE EARTH-2 ENCOUNTER

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Early in 1992, it became evident that the Galileo Earth-2 encounter would provide an excellent opportunity to try out advanced visualization concepts on planetary mission data. A demonstration was conducted using equipment and software that was not part of the formal Galileo mission operations system, and was performed on a "best efforts" basis, Constrained by the resources available to support this task. The demonstration was designed to prove that use of existing visualization packages developed at JPL or commercially available would enable implementation of real time display of science data at extremely low cost. The Magnetometer (MAG), Plasma Wave Subsystem (PWS) and Ultra-violet Spectrometer (UVS) teams and their experiment representatives agreed to support this demonstration, and participated in development, implementation and operation of the display systems developed for each of their instruments. Development of the prototype activities described in this report enabled maximum science return from the Earth-2 encounter, and science analysis was performed on much shorter time scales than had been experienced previously.

The visualization data prototyping activity received data from the Near Real Time (NERT-II) developed under Galileo Project funding to provide instrument data frames to science investigators at JPL or remote sites in real time during the Earth-2 encounter in December 1992. Individual Unix workstations were assigned to specific instruments for data visualization during encounter operations.

PWS Low Rate data was processed on a Silicon Graphics workstation using the Linked Windows Interactive Data System (LinkWinds) under development in JPL's Division 32. LinkWinds was modified to accept stream data for realtime display and analysis. In addition to the standard spectrogram display, applications which rendered the data as a height field, showed spectral intensity line plots, and gave timing information were developed, interactive selection of time and frequency intervals and adjustment of color scales was available to the scientists. PWS High Rate data was transferred to a Silicon Graphics workstation from the Multimission Image Processing System (MIPS). Areas of interest were identified from the low rate display, and the full set of high rate data for that time period was then transferred from MIPS for further analysis using PVWave, a commercially available data visualization package. As with the low rate display, the perspective view, color lookup table, and data height gain could all be modified in real time by the user.

UVS processing was performed using a color Sun Sparcstation and X Windows. Data was extracted in 4.333 second spectra, equivalent to 6.5 minor frames of spacecraft clock (SCLK) time. It was time tagged with SCLK and spacecraft event time (SCET) and a false color display of accumulated spectra was developed and built up in real time as the data was acquired, A strip chart paper recorder was also provided in response to

requests from the science team. 'l"he recorder provided significantly higher resolution than available on the display screen.

The Magnetometer experiment was supported with a Sun color Sparcstation and X-Windows. The software was developed on a short time scale prior to encounter using a workstation at the PI's home institution (UCLA) where a SPICE interface and magnetosphere models were available. An X-Window display at JPL was used for remote operations using a UCLA system as a server. The visualization program displayed a three dimensional view of the planetary epheremis, the spacecraft trajectory, and the magnetic strength vector field, with the perspective controlled by mouse and keyboard. The user was able to change the sampling rate and the type of coordinate system using a simple menu button. Users could change perspective view, viewing distance, and other parameters interactively.

The NERT-II capability and the data visualization prototype provided effective real time data transfer and analysis capabilities to PI's located at JPL and remote facilities during the Earth-2 encounter. The use of a rapid prototyping development approach for display and analysis packages that could be used in real time by science users provided an effective means of delivering a useful capability during encounter operations. The rapid prototyping development activity featuring frequent direct interaction with the end users was achieved outside of the normal project change control procedures, which is an appropriate approach for science analysis support software that does not affect spacecraft operations or the health and safety of the spacecraft and instrument payload.

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